

Air Force Weather Agency

**Advance slide after
beep:**

Right or Down Arrow

Previous Slide:

Left or Up Arrow

Approved for Public Release April 2012



Air Force Weather Agency

Space Weather presents...

Solar Structure – Layers of the Sun

**Advance slide after
beep:**

Right or Down Arrow

Previous Slide:

Left or Up Arrow



Space Weather

Solar Structure – Layers of the Sun

Purpose

Gain basic understanding of solar layers

Objectives

Learn the layers of the sun

Know how they interact

Understand how they relate to solar output



Space Weather

Solar Structure – Layers of the Sun

Overview

Gain basic understanding of solar layers

Interior

- Core
- Radiation Zone
- Convection Zone

Surface

Objectives

- Photosphere

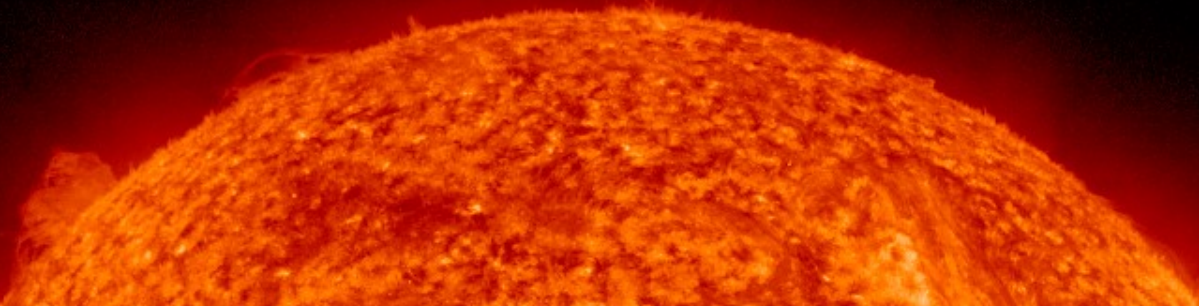
Atmosphere

- Chromosphere
- Corona

Learn the layers of the sun

Know how they interact

Understand how they relate to solar output





Space Weather

Solar Structure – Layers of the Sun

Overview

Interior

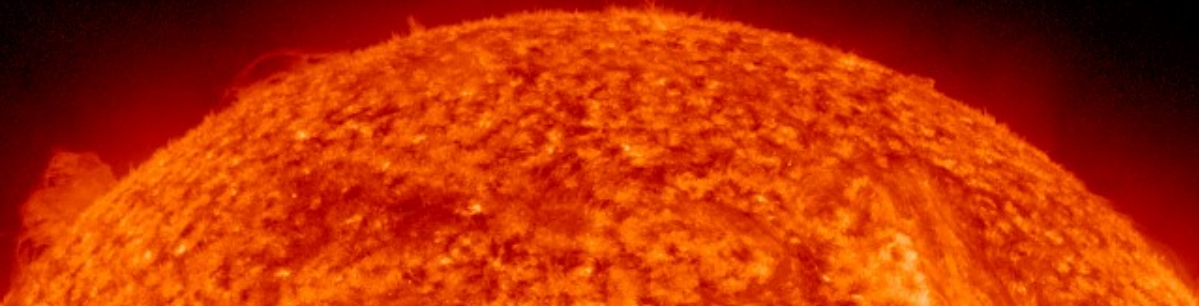
- Core
- Radiation Zone
- Convection Zone

Surface

- Photosphere

Atmosphere

- Chromosphere
- Corona



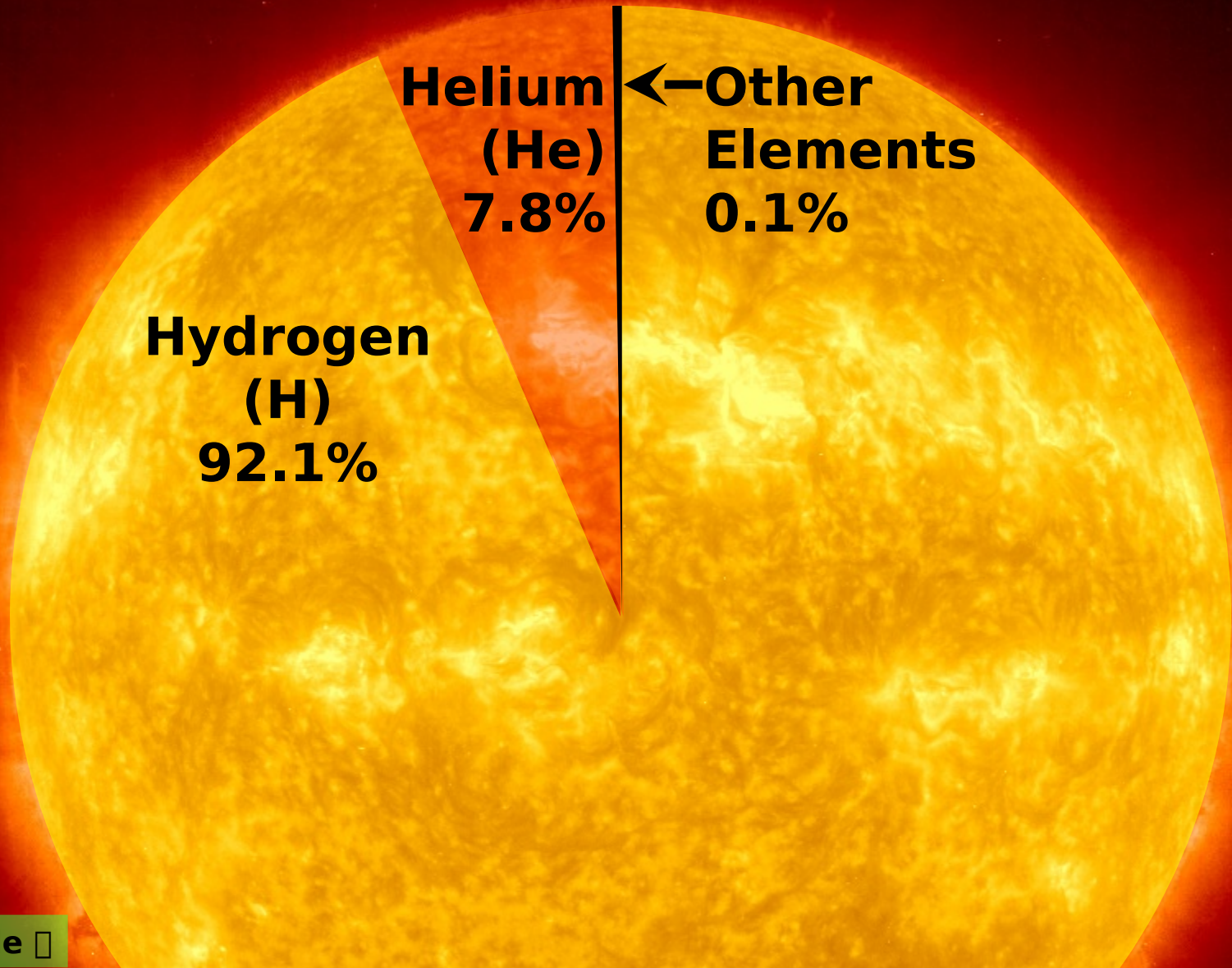


Size Compared to the Sun





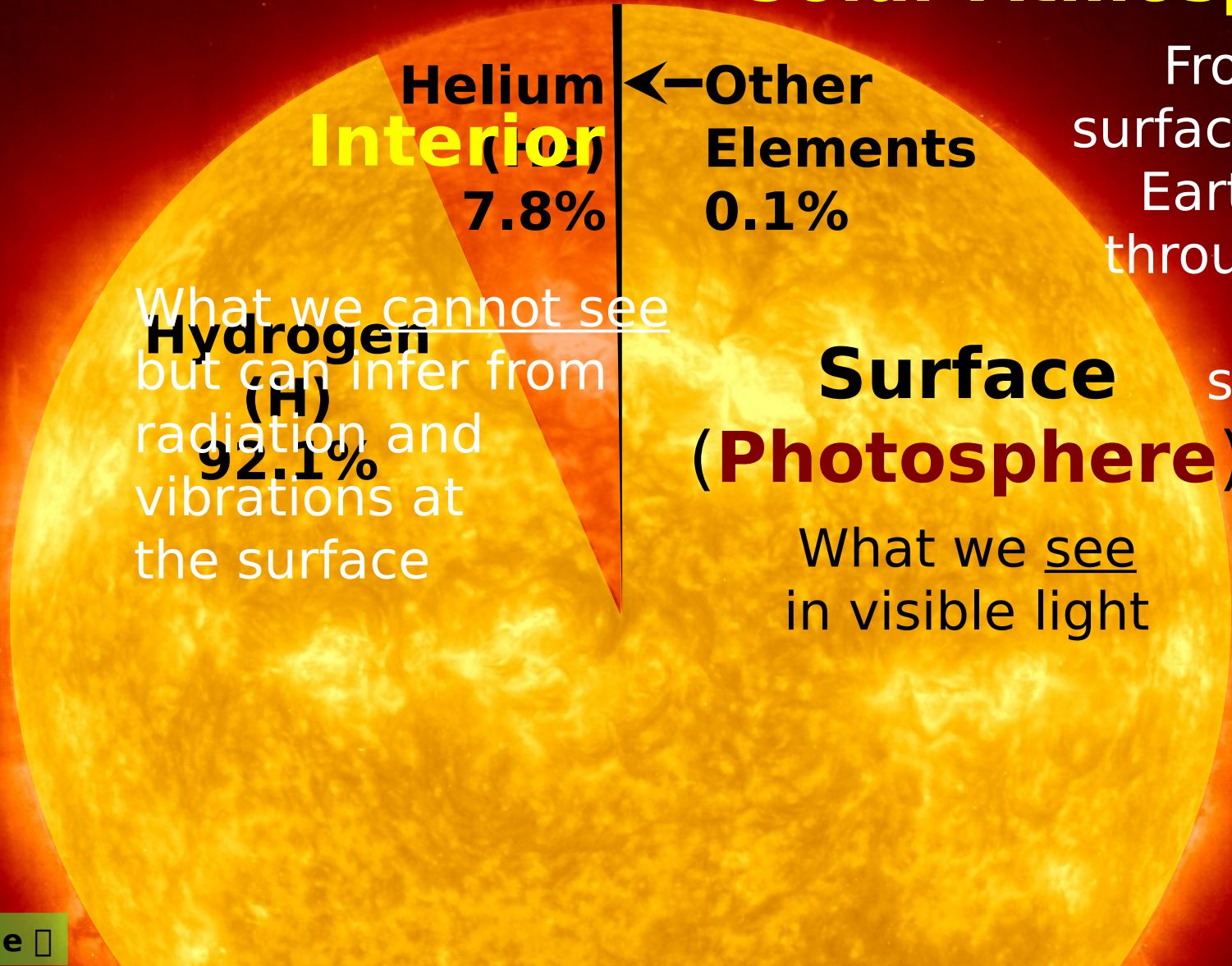
Size of Solar Composition to the Sun





Solar Composition

Solar Atmosphere



What we cannot see
but can infer from
radiation and
vibrations at
the surface

**Helium
(He)**
7.8%

**Other
Elements**
0.1%

**Surface
(Photosphere)**

What we see
in visible light

From the
surface past
Earth and
throughout
solar
system



Solar

Solar Atmosphere



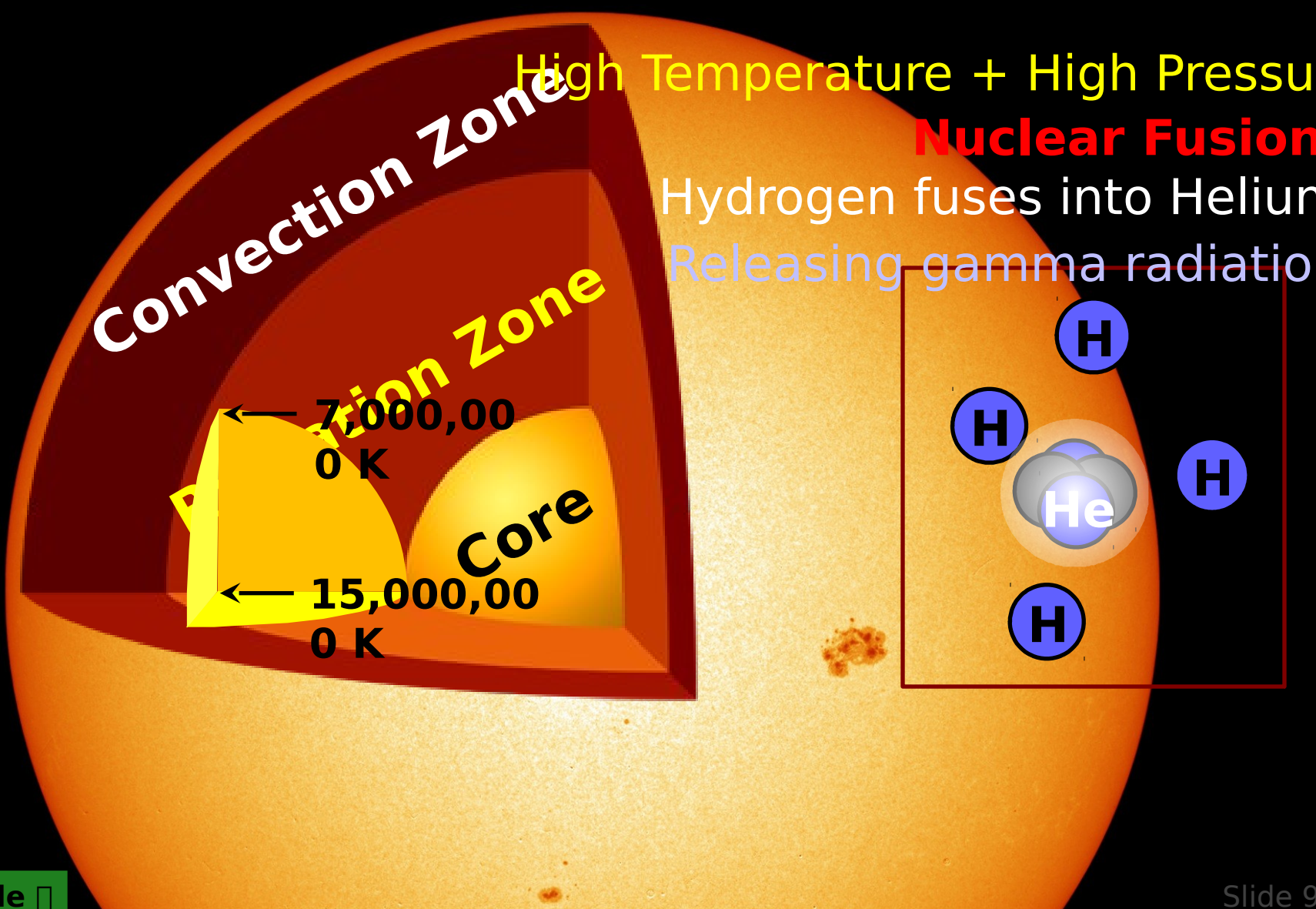
Interior
What we cannot see
but can infer from
radiation and
vibrations at
the surface

From the
surface past
Earth and
throughout
solar
system

Surface
(**Photosphere**)
What we see
in visible light



SolarCore





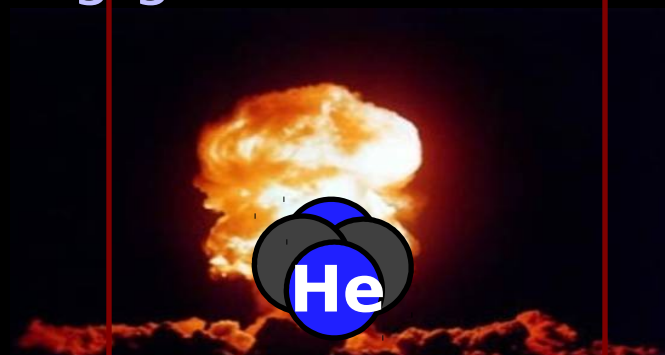
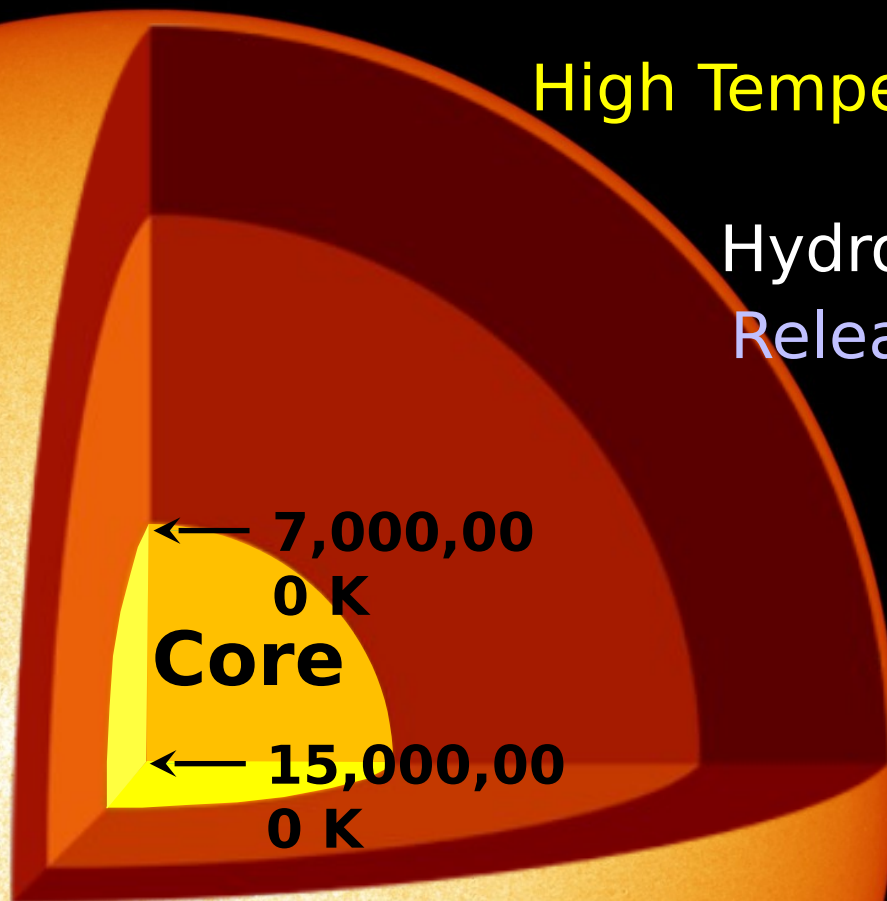
SolarCore

High Temperature + High Pressure

Nuclear Fusion:

Hydrogen fuses into Helium

Releasing gamma radiation



= 300,000,000,000
hydrogen bombs

5,000,000,000 kg of hydrogen
converted to helium.

...every single Second



Solar Radiation Zone

High Temperature + High Pressure

Nuclear Fusion:

Hydrogen fuses into Helium

Releasing gamma radiation

← 2,000,000 K
Radiation Zone

← 7,000,000 K
Core

← 15,000,000 K



= 300,000,000,000
Hydrogen Bombs

5,000,000,000 kg of Hydrogen
converted to Helium

Every Single Second

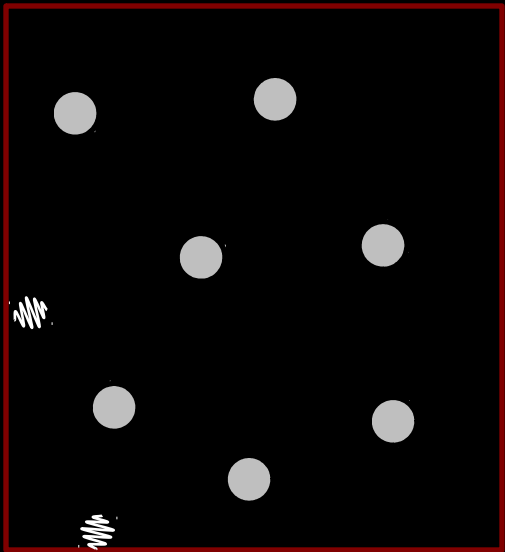
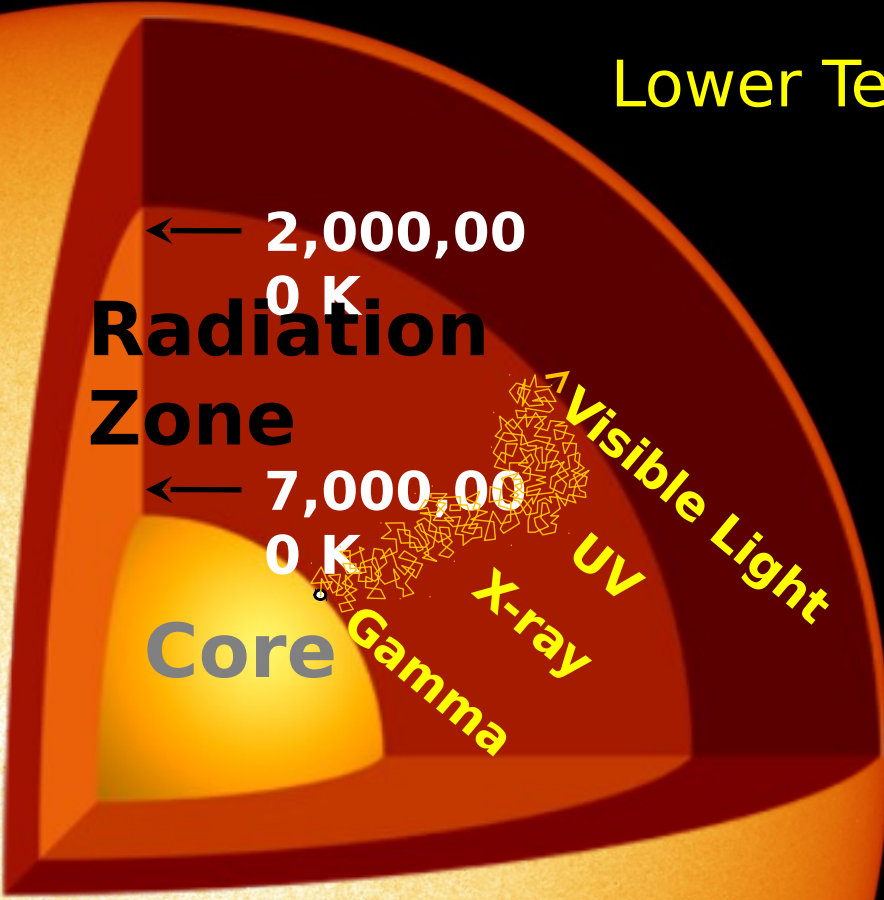


Solar Radiation Zone

Lower Temperature & Pressure

Radiation:

From atom to atom



Successively longer wavelength

~

for energy to escape the radiation zone



Solar Radiation Zone

Convection Zone

Lower Temperature & Pressure

Radiation Zone

Radiation:

From atom to atom

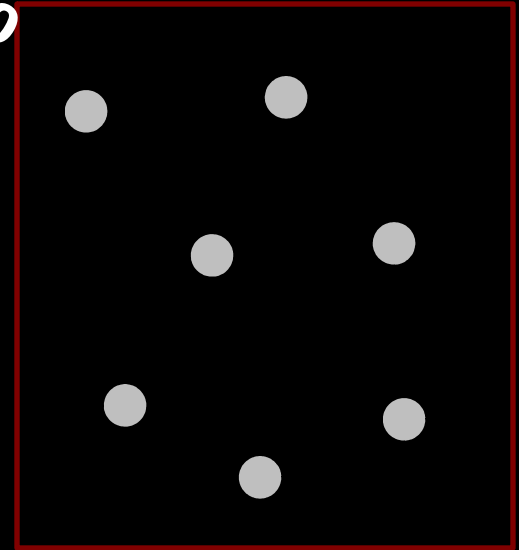
6,000 K
2,000,000 K

Visible Light
UV

X-ray

Core

Gamma



Successively longer wavelength

~1,000,000 years

for energy to

escape the radiation zone



Solar Convection Zone

Surface cooling

Convection:
Heat source
from below

**Convection
Zone**

Rising

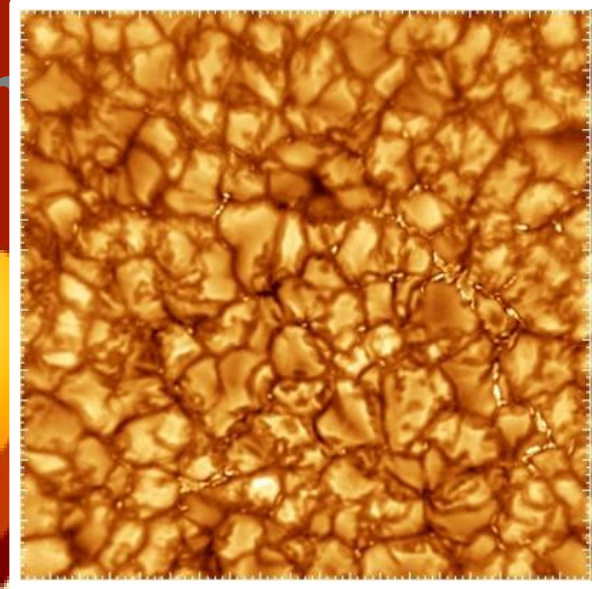
Sinking

Heating

$\sim 6,000\text{ K}$

**Radiation
Zone**

Core



"Granulation"

Evidence seen at base of photosphere



Photosphere Zone

Surface cooling

Convection:

Heat source
from below

**Convection
Zone**

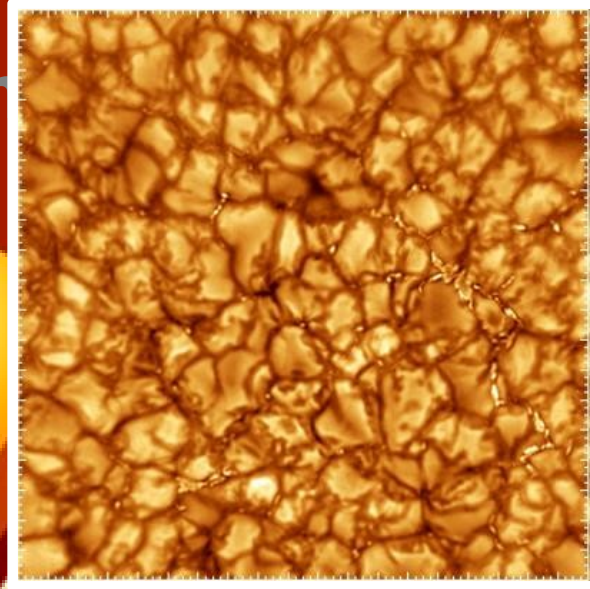
Rising

Sinking

Heating

**Radiation
Zone**

Core



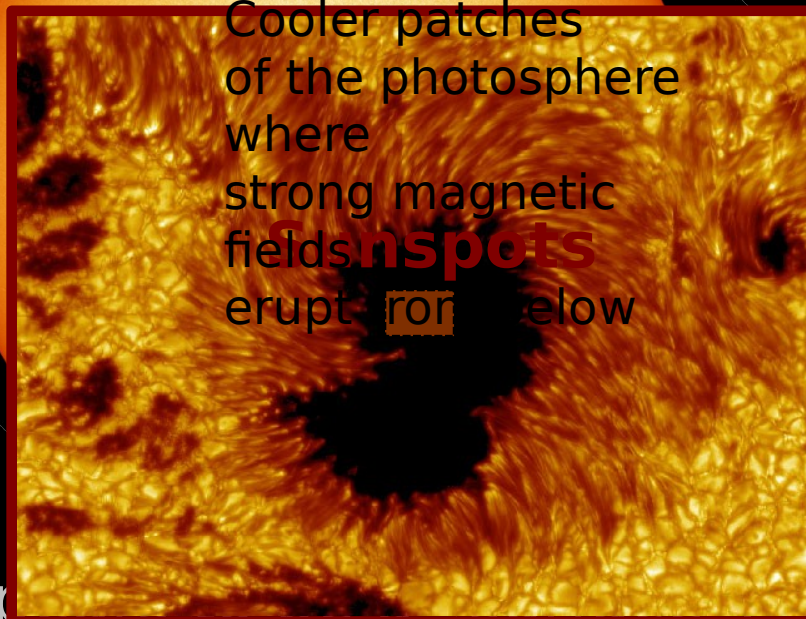
"Granulation"



Photosphere

The part of the Sun we see in visible light

~5,800 K



App



A **candle flame** has the same appearance.

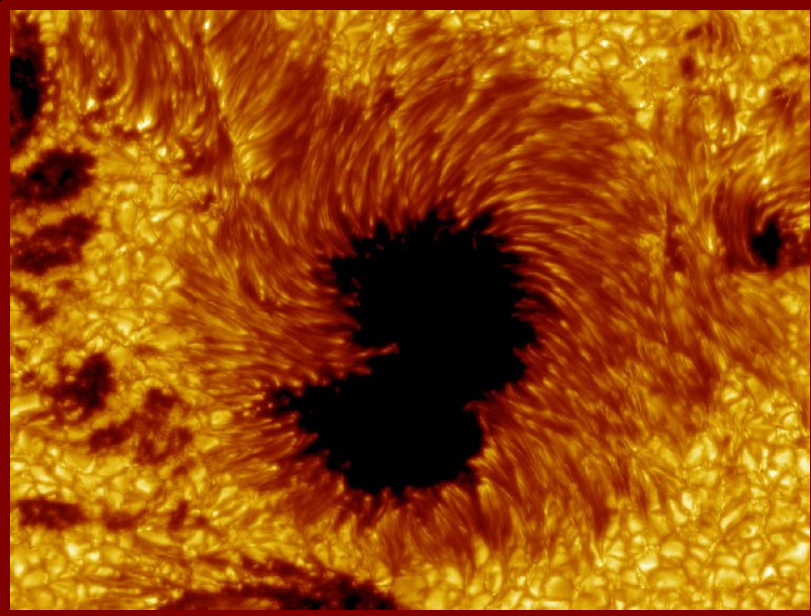
Its “surface” is not solid, but is where hotter gases glow.



Photosphere

The part of the ~~Rotation~~ Surface in visible light

~5,800 K



Sunspots

Cooler patches
of the photosphere
where
strong magnetic
fields
erupt from below



Appears to be a “surface”.

A **candle flame** has the same appearance.

Its “surface” is not solid, but is where hotter gases glow.

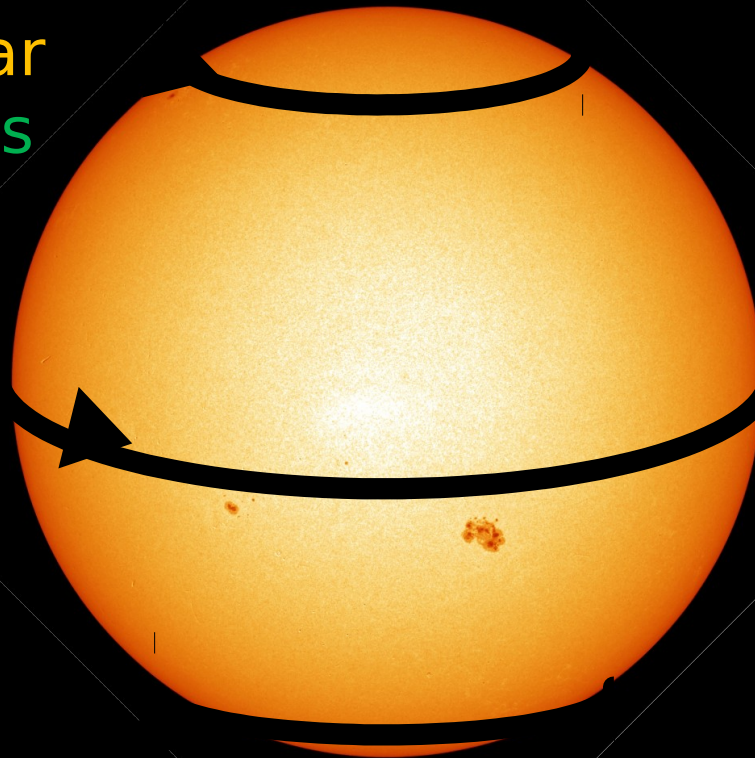


Photosphere

Rotation

Rotation
near Solar
Poles
~35 days

Rotation at
Solar
Equator
~25 days



Average
Solar
Rotation
~27 days

From Earth's perspective

(as it's traveling in its orbit around the Sun)

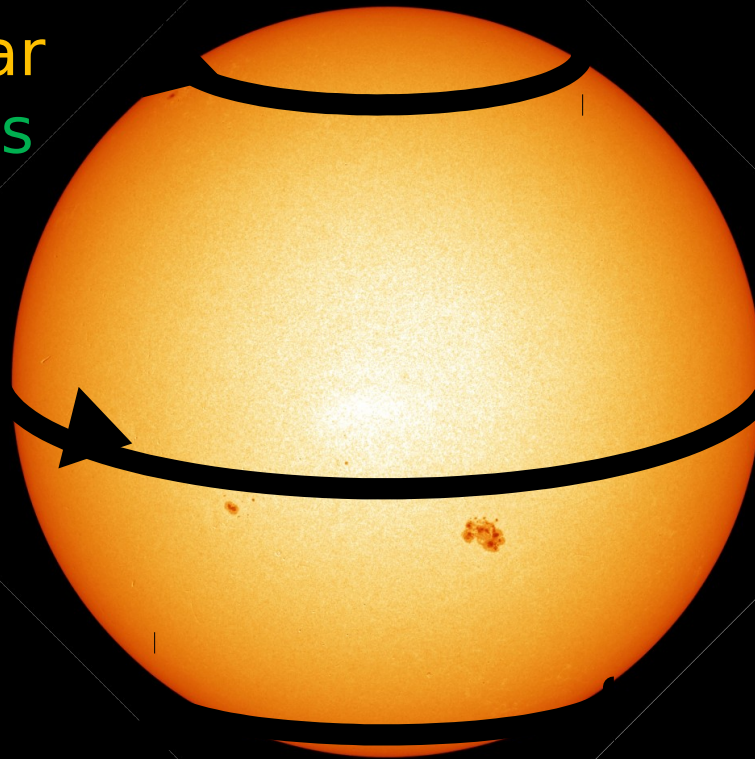


Solar Atmosphere

Rotation

Rotation
near Solar
Poles
~ 35 days

Rotation at
Solar
Equator
~ 25 days



Average
Solar
Rotation
27 days

From Earth's perspective

(as it's traveling in its orbit around the Sun)



Solar Atmosphere

Corona
(As seen during eclipse)





Solar Atmosphere

6,000 – 20,000 K

Solar Flare

Twisted magnetic fields suddenly relax

Extreme heating

Burst of radio waves

Burst of x-rays

Charged gas

accelerated
Protons kicked to nearly light speed

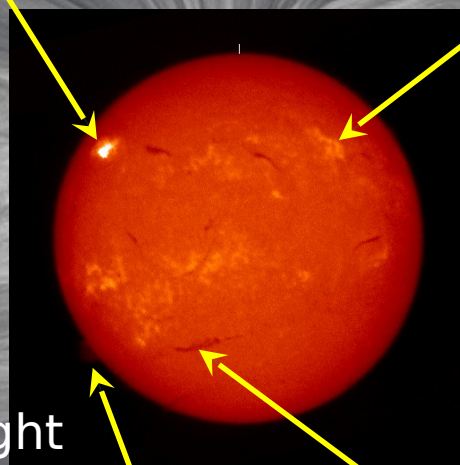
Corona

(As seen during eclipse)

Solar Plage

Magnetic fields strong and twisted

Sunspots below these active regions



Solar Prominence & Filament

Same phenomenon:
suspended gases above the photosphere
background

A **prominence** is viewed at the solar limb appearing brighter than

A **filament** is viewed on the solar disk appearing darker



Solar Corona

20,000 – 2,000,000 K

Much hotter than photosphere





Solar Corona

20,000 – 2,000,000 K

Much hotter than photosphere

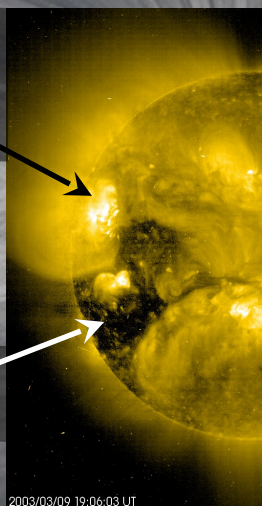
Active Region

(sunspots below)

Prone to Flares

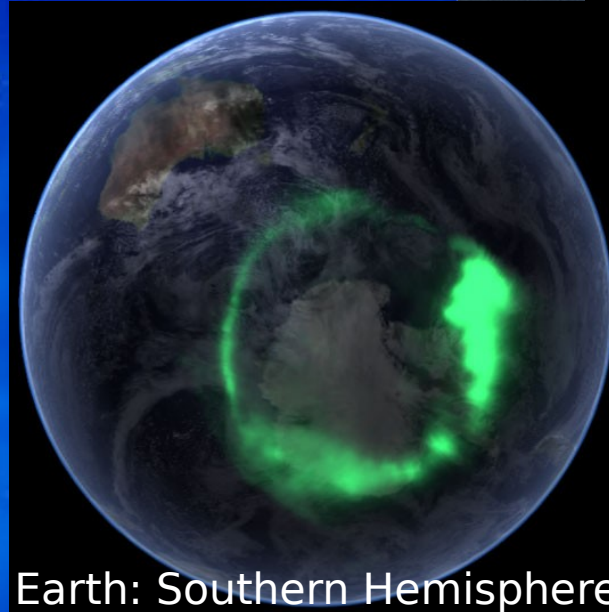
Coronal Hole

Prone to fast electrons



X-ray image

Visible image



Earth: Southern Hemisphere

Coronal Mass Ejection

Can disturb Earth's magnetic field

Aurora on Earth often results



Solar Corona

Summary

20,000 – 2,000,000 K
Much hotter than photosphere

Interior

Active Region

(sun spots below) Zone

Prone to Flares
Convection Zone

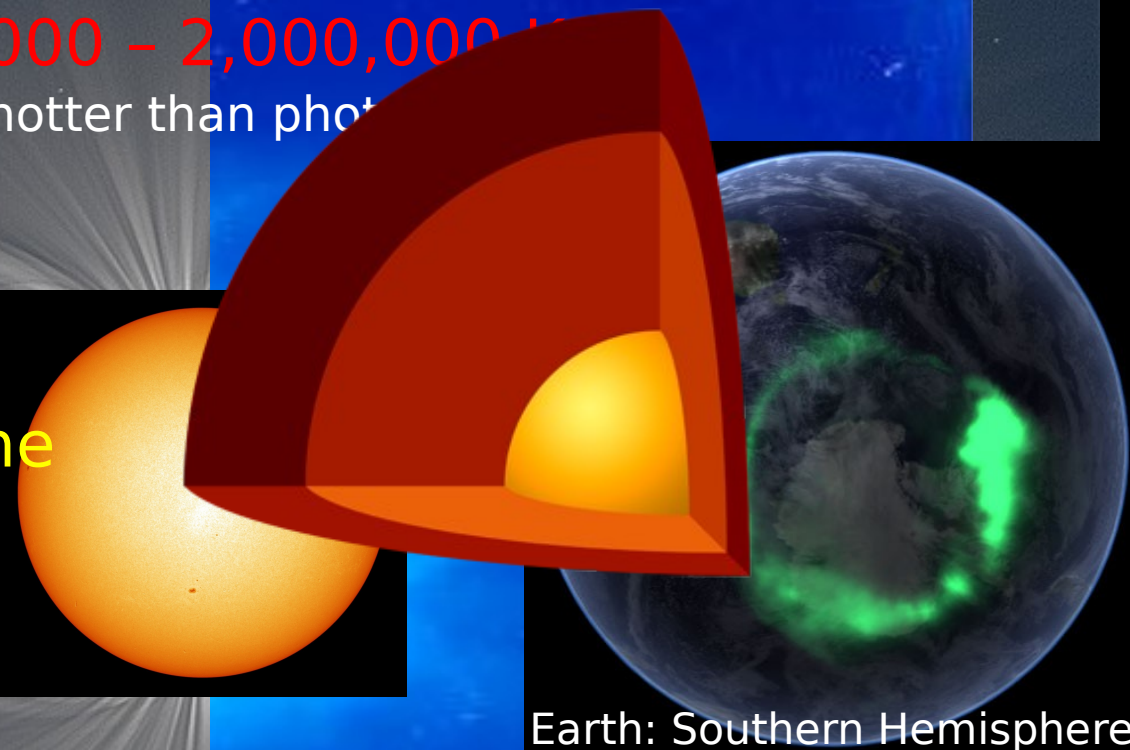
Surface

Coronal Hole

Photosphere
Prone to fast electrons

Atmosphere

Chromosphere
Corona



Earth: Southern Hemisphere

X-ray image Visible image

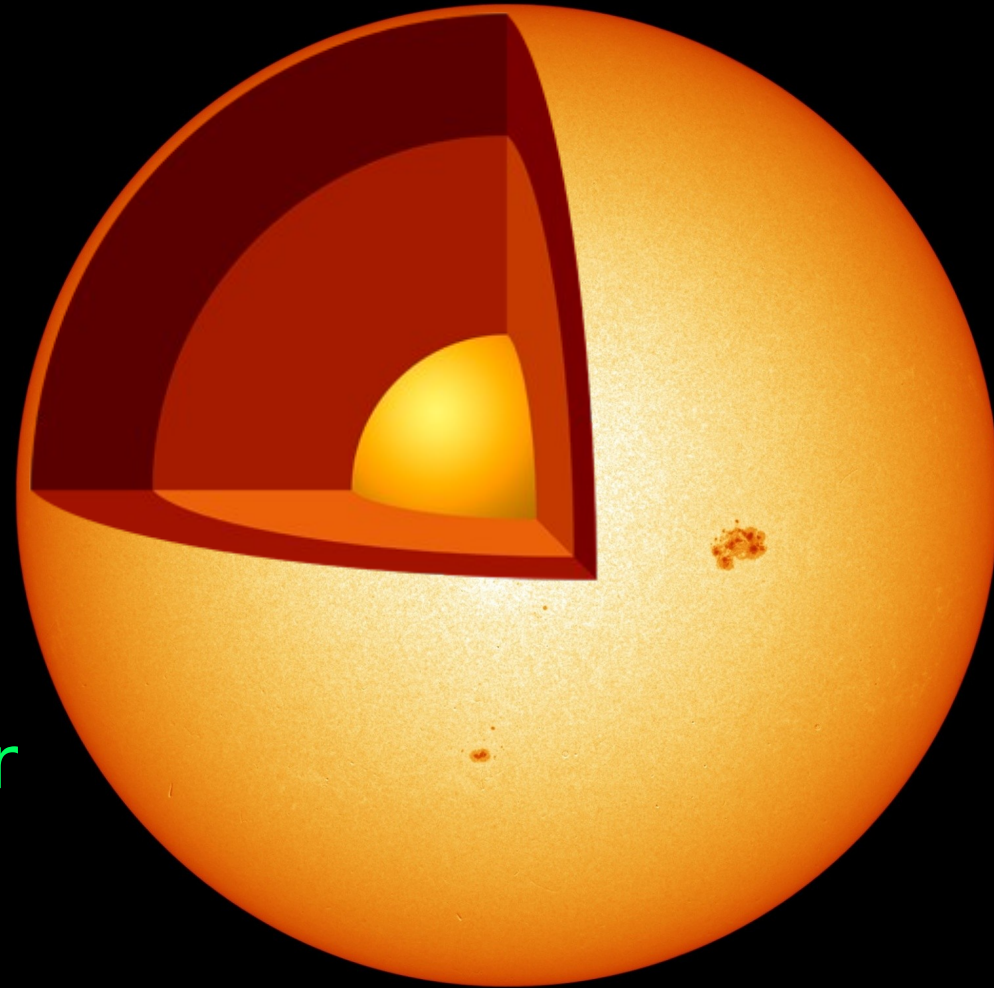
Coronal Mass Ejection

Can disturb Earth's magnetic field
Aurora on Earth often results



Contribution

- Identify solar layers
 - Core
- Understand interaction between layers
 - Radiation Zone
 - Convection Zone
- Learn significant effects of each layer
 - Surface
 - Photosphere
 - Atmosphere
 - Chromosphere
 - Corona



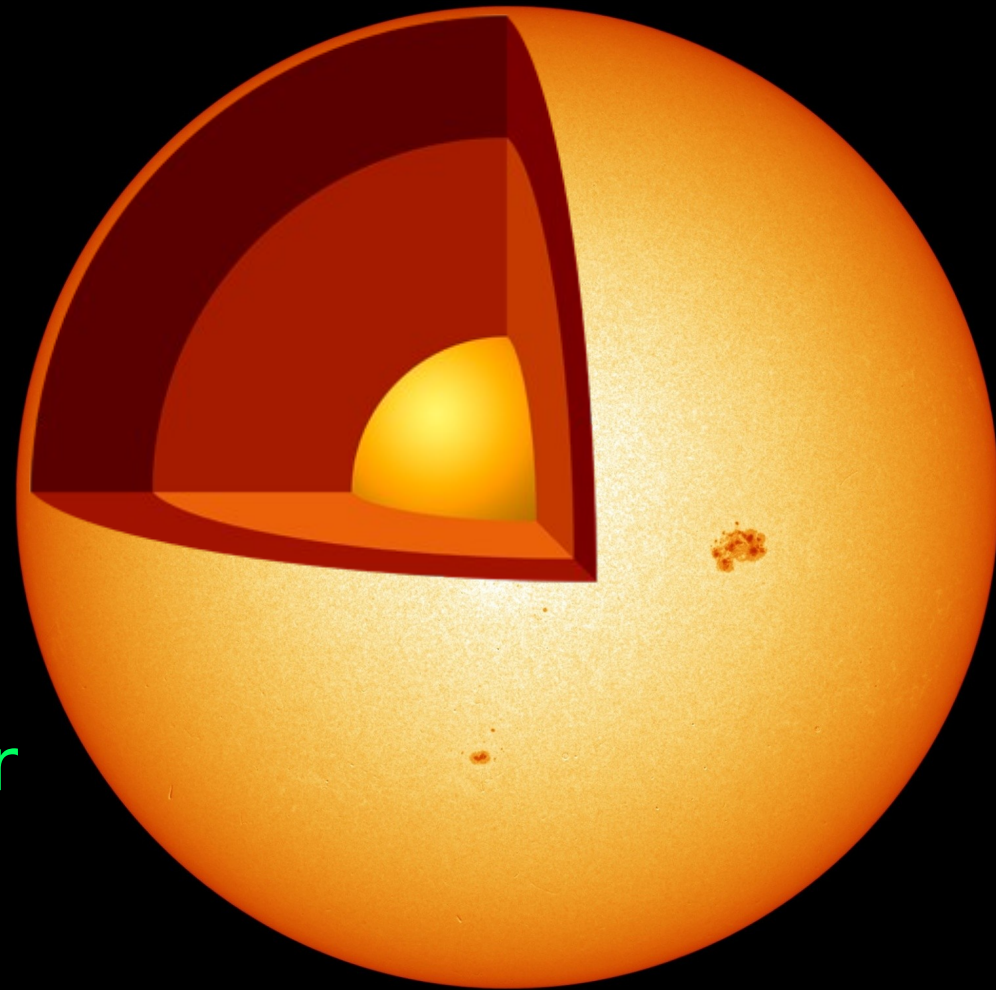


Final Thoughts

Now: Identify solar layers

Understand
- Understand
fundamentals of solar
interaction
structure
between layers

Later:
- Learn significant
effects of each layer
Further detail about
cause of solar activity
and its impacts



Air Force Weather

Final Thoughts Agency

Now:

Understand
fundamentals of solar
structure

Later:

Further detail about
cause of solar activity
and its impacts

